IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Mann et al.
Serial No:	Not Yet Assigned
For:	6-MIRROR MICROLITHOGRAPHY PROJECTION OBJECTIVE
Filed:	Concurrently Herewith
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

Docket No.: 637.0008USU

PRELIMINARY AMENDMENT

Box: Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Preliminary to examination, please amend the above-noted patent application as follows:

IN THE SPECIFICATION

Please amend the portions of the Specification identified below to read as indicated herein. A version of the amended portions of the Specification with markings to show changes made is included at the end of this document.

Paragraph starting at page 1, line 7:

The present invention relates to a microlithography objective and, more particularly, to a microlithography projection objective for short wavelengths, preferably ≤ 193nm, a projection exposure system that includes such a microlithography projection objective, and a chip manufacturing process that employs such a projection exposure system.

IN THE ABSTRACT

Please delete the abstract in its entirety, and replace it with the version provided below.

There is provided a microlithography projection objective for short wavelengths, with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents a segment of a ring field, in which the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm. The objective comprises a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5) and a sixth mirror (S6) in centered arrangement relative to an optical axis. Each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge. The diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is ≤ 1200 mm * NA.

IN THE CLAIMS

Please amend the claims to read as indicated herein. A version of the amended claims with markings to show changes made is included at the end of this document.

1. (Amended) Microlithography projection objective for short wavelengths, with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents a segment of a ring field, wherein the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm, comprising:

a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5) and a sixth mirror (S6) in centered arrangement relative to an optical axis,

wherein each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge, and

wherein the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is ≤ 1200 mm * NA.

2. (Amended) Microlithography projection objective according to claim 1, wherein the numerical aperture NA at the exit pupil is greater than 0.1, and the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors is ≤ 300 mm.

3. (Amended) Microlithography projection objective according to claim 1,

wherein the first, second, third, fourth, fifth and sixth mirrors each have a volume claim on the rear side of the mirror, which has a depth parallel to the optical axis measured from the front side of the mirror in the off-axis segment,

wherein the depth of the volume claims of the first, second, third, fourth, and sixth mirrors is at least 50mm, and the depth of the volume claim of the fifth mirror is greater than 1/3 the value of the diameter of the fifth mirror, and

wherein the respective volume claims are not penetrated.

4. (Amended) Microlithography projection objective according to claim 3, wherein all volume claims can be extended in a direction parallel to the axis of symmetry without intersecting the light path in the objective or the volume claim of another mirror.

5. (Amended) Microlithography projection objective according to claim 1,

wherein the first, second, third, fourth, fifth and sixth mirrors include an edge region encircling the off-axis segment, and the edge region amounts to more than 4 mm, and

wherein the light is guided in the objective free of obscuration.

6. (Amended) Microlithography projection objective according to claim 1, wherein the off-axis segment of the fourth mirror is arranged geometrically between the second mirror and the image plane.

7. (Amended) Microlithography projection objective according to claim 1, wherein the fourth mirror is arranged geometrically between the third and the second mirrors.

8. (Amended) Microlithography projection objective according to claim 1, wherein the fourth mirror is arranged geometrically between the first and the second mirrors.

9. (Amended) Microlithography projection objective according to claim 1, wherein the distance of the mirror vertex along the optical axis from the fourth to the first mirrors (S4 S1) relative to the distance from the second to the first mirror (S2 S1) lies in the range:

$$0.1 < (S4\ S1) / (S2\ S1) < 0.9.$$

10. (Amended) Microlithography projection objective according to claim 1, wherein the distance of the mirror vertex along the optical axis from the third to the second mirror (S2 S3) relative to the distance from the fourth to the third mirror (S4 S3) lies in the range:

$$0.3 < (S3\ S4) / (S2\ S3) < 0.9.$$

11. (Amended) Microlithography projection objective according to claim 1, wherein the central ring-field radius R, as a function of the numerical aperture NA at the exit pupil, the distance of the mirror vertex along the optical axis from the fifth to the sixth mirror (S5 S6), the distance of the mirror vertex of the fifth mirror from the image plane (S5 B), and the radii of curvature r_5, r_6 of the fifth and sixth mirrors is:

$$R \geq \tan(\arcsin(NA)) * \left[(S5\,B) + (S5\,S6) - \frac{1}{\frac{2}{r_6} - \frac{1}{r_5 + (S5\,S6)}} \right].$$

12. (Amended) Microlithography projection objective according to claim 1, further comprising an angle of incidence of a chief ray of a field point,

wherein the field point lies on the axis of symmetry in the center of the object field, and

wherein the angle of incidence is < 18° on all mirrors.

13. (Amended) Microlithography projection objective according to claim 1, wherein an intermediate image is formed in the projection objective in the light direction after the fourth mirror (S4).

14. (Amended) Microlithography projection objective according to claim 1, further comprising a diaphragm (B) that is arranged in a light path or a beam path on the second mirror (S2).

15. (Amended) Microlithography projection objective according to claim 1, wherein the first mirror is made convex, and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

16. (Amended) Microlithography projection objective according to claim 1, wherein the first mirror has zero base curvature, and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

17. (Amended) Microlithography projection objective according to claim 1, wherein the first mirror is concave and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

18. (Amended) Microlithography projection objective according to claim 1, wherein all mirrors are aspheric.

19. (Amended) Microlithography projection objective according to claim 1, wherein five mirrors at most are aspheric.

20. Microlithography projection objective according to claim 19, wherein the fourth mirror is spherical.

21. (Amended) Microlithography projection objective according to claim 1, wherein the second to sixth mirrors (S2 S6) are configured in the sequence: concave – convex - concave– convex - concave.

22. (Amended) Microlithography projection objective according to claim 1, wherein the objective is telecentric on the image side.

23. (Amended) Projection exposure system, comprising:
an illumination device for illuminating a ring field; and
a projection objective according to claim 1.

24. (Amended) Process for chip manufacture comprising using a projection exposure system according to claim 23.

Please add the following claims:

25. (New) Microlithography projection objective for short wavelengths, with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents a segment of a ring field, wherein the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm, comprising:

a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5) and a sixth mirror (S6) in centered arrangement relative to an optical axis,

wherein each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge,

wherein the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is $\leq$1200 mm * NA,

wherein the first, second, third, fourth, fifth and sixth mirrors each have a volume claim on the rear side of the mirror, which has a depth parallel to the optical axis measured from the front side of the mirror in the off-axis segment,

wherein the depth of the volume claims of the first, second, third, fourth, and sixth mirrors is at least 50mm, and the depth of the volume claim of the fifth mirror is greater than 1/3 the value of the diameter of the fifth mirror,

wherein the respective volume claims are not penetrated, and

wherein all volume claims can be extended in a direction parallel to the axis of symmetry without intersecting the light path in the objective or the volume claim of another mirror.

26. (New) Microlithography projection objective for short wavelengths, with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents a segment of a ring field, wherein the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm, comprising:

a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5) and a sixth mirror (S6) in centered arrangement relative to an optical axis,

wherein each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge,

wherein the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is $\leq$1200 mm * NA, and

wherein the distance of the mirror vertex along the optical axis from the fourth to the first mirrors (S4 S1) relative to the distance from the second to the first mirror (S2 S1) lies in the range:

$$0.1 < (S4\ S1) / (S2\ S1) < 0.9.$$

27. (New) Microlithography projection objective for short wavelengths, with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents a segment of a ring field, wherein the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm, comprising:

a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5) and a sixth mirror (S6) in centered arrangement relative to an optical axis,

wherein each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge,

wherein the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is ≤1200 mm * NA, and

wherein the distance of the mirror vertex along the optical axis from the third to the second mirror (S2 S3) relative to the distance from the fourth to the third mirror (S4 S3) lies in the range:

$$0.3 < (S3\ S4) / (S2\ S3) < 0.9.$$

REMARKS

This application contains claims 1 through 27. Claims 25 through 27 are newly added. The present application is a result of a translation from German into English. The specification was amended to employ terminology in accordance with U.S. practice. The claims were amended to eliminate multiple dependencies, to improve form, and to employ terminology in accordance with U.S. practice.

Respectfully submitted,

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Date

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VERSION MARKED TO SHOW CHANGES MADE

IN THE SPECIFICATION

Paragraph starting at page 1, line 7:

The present invention [concerns] relates to a microlithography objective [according to the preamble of claim 1] and, more particularly, to a microlithography projection objective for short wavelengths, preferably ≤ 193nm, a projection exposure system [according to claim 23] that includes such a microlithography projection objective, [as well as] and a chip manufacturing process [according to claim 24] that employs such a projection exposure system.

IN THE CLAIMS

1. (Amended) Microlithography projection objective for short wavelengths, [preferably ≤ 193 nm,] with an entrance pupil and an exit pupil for imaging an object field in an image field, which represents [the] a segment of a ring field, wherein the segment has an axis of symmetry and an extension perpendicular to the axis of symmetry and the extension is at least 20mm, [and preferably 25 mm,] comprising:

a first (S1), a second (S2), a third (S3), a fourth (S4), a fifth (S5)[,] and a sixth mirror (S6) in centered arrangement relative to an optical axis, [whereby]

wherein each of these mirrors have an off-axis segment, in which the light beams traveling through the projection objective impinge, and

[whereby]

wherein the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors as a function of the numerical aperture NA of the objective at the exit pupil is ≤1200 mm * NA.

2. (Amended) Microlithography projection objective according to claim 1, wherein the numerical aperture NA at the exit pupil is greater than 0.1, [preferably greater than 0.2, most

preferably greater than 0.23], and the diameter of the off-axis segment of the first, second, third, fourth, fifth and sixth mirrors is ≤ 300 mm.

3. (Amended) Microlithography projection objective according to [one of claims 1 to 2] claim 1,

wherein the first, second, third, fourth, fifth and sixth mirrors each have a volume claim on the rear side of the mirror, which has a depth parallel to the optical axis measured from the front side of the mirror in the off-axis segment,

[whereby the depth amounts to at least 50 mm for] wherein the depth of the volume claims of the first, second, third, fourth, and sixth [volume claim] mirrors is at least 50mm, and the depth of the volume claim of the fifth mirror is greater than 1/3 the value of the diameter of the fifth mirror, and

[whereby] wherein the respective volume claims are not penetrated.

4. (Amended) Microlithography projection objective according to [one of claims 1 to 3] claim 3, wherein all volume claims can be extended in a direction parallel to the axis of symmetry without intersecting the light path in the objective or the volume claim of another mirror.

5. (Amended) Microlithography projection objective according to claim 1,

wherein the first, second, third, fourth, fifth and sixth mirrors include an edge region encircling the off-axis segment, and the edge region amounts to more than 4 mm, and

wherein the light is guided in the objective free of obscuration.

6. (Amended) Microlithography projection objective according to [one of claims 1 to 4] claim 1, wherein the off-axis segment of the fourth mirror is arranged geometrically between the second mirror and the image plane.

7. (Amended) Microlithography projection objective according to [one of claims 1 to 6] claim 1, wherein the fourth mirror is arranged geometrically between the third and the second mirrors.

8. (Amended) Microlithography projection objective according to [one of claims 1 to 6] claim 1, wherein the fourth mirror is arranged geometrically between the first and the second mirrors.

9. (Amended) Microlithography projection objective according to [one of claims 1 to 6] claim 1, wherein the distance of the mirror vertex along the optical axis from the fourth to the first mirrors (S4 S1) relative to the distance from the second to the first mirror (S2 S1) lies in the range:

$$0.1 < (S4\ S1) / (S2\ S1) < 0.9.$$

10. (Amended) Microlithography projection objective according to [one of claims 1 to 8] claim 1, wherein the distance of the mirror vertex along the optical axis from the third to the second mirror (S2 S3) relative to the distance from the fourth to the third mirror (S4 S3) lies in the range:

$$0.3 < (S3\ S4) / (S2\ S3) < 0.9.$$

11. (Amended) Microlithography projection objective according to [one of claims 1 to 8] claim 1, wherein the central ring-field radius R, as a function of the numerical aperture NA at the exit pupil, the distance of the mirror vertex along the optical axis from the fifth to the sixth mirror (S5 S6), the distance of the mirror vertex of the fifth mirror from the image plane (S5 B), and the radii of curvature r_5, r_6 of the fifth and sixth mirrors is:

$$R \geq \tan(\arcsin(NA)) * \left[(S5\,B) + (S5\,S6) - \frac{1}{\frac{2}{r_6} - \frac{1}{r_5 + (S5\,S6)}} \right].$$

12. (Amended) Microlithography projection objective according to [one of claims 1 to 11] claim 1, [wherein the] further comprising an angle of incidence of [the] a chief ray of [the] a field point, [which]

wherein the field point lies on the axis of symmetry in the center of the object field, and wherein the angle of incidence is < 18° on all mirrors.

13. (Amended) Microlithography projection objective according to [one of claims 1 to 12] claim 1, wherein an intermediate image is formed in the projection objective in the light direction after the fourth mirror (S4).

14. (Amended) Microlithography projection objective according to [one of claims 1 to 13] claim 1, [wherein] further comprising a diaphragm (B) that is arranged in [the] a light path or [the] a beam path on the second mirror (S2).

15. (Amended) Microlithography projection objective according to [one of claims 1 to 14] claim 1, wherein the first mirror is made convex, and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

16. (Amended) Microlithography projection objective according to [one of claims 1 to 14] claim 1, wherein the first mirror has zero base curvature, and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

17. (Amended) Microlithography projection objective according to [one of claims 1 to 14] claim 1, wherein the first mirror is concave and the first, second, third, fourth, fifth and sixth mirrors are aspheric.

18. (Amended) Microlithography projection objective according to [one of claims 1 to 17] claim 1, wherein all mirrors are [made] aspheric.

19. (Amended) Microlithography projection objective according to [one of claims 1 to 17] claim 1, wherein five mirrors at most are aspheric.

21. (Amended) Microlithography projection objective according to [one of claims 1 to 20] claim 1, wherein the second to sixth mirrors (S2 S6) are configured in the sequence: concave – convex - concave– convex - concave.

22. (Amended) Microlithography projection objective [device] according to [one of claims 1 to 21] claim 1, wherein the objective is telecentric on the image side.

23. (Amended) Projection exposure system, [wherein the projection exposure system comprises] comprising:

an illumination device for illuminating a ring field [as well as]; and

a projection objective according to [one of claims 1 to 22] claim 1.

24. (Amended) Process for chip manufacture [with] comprising using a projection exposure system according to claim 23.